

PATENT ABSTRACTS OF JAPAN

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(54) TRIPLET LENS FOR PHOTOGRAPHY

(57)Abstract:

PURPOSE: To reduce the size and obtain high performance by arranging 1st-3rd groups from a stop side to an image side, setting condition parameters within a specific range, and forming an aspherical surface which has a cone constant in a specific range as a lens surface including the image plane side of the 3rd group.

$$-0.53 < f_3/f < -0.38$$

I

CONSTITUTION: The 1st-3rd lens groups are arranged on the image side of a stop positioned before an object side in order from the stop side to the image side. The 1st group is a biconvex lens, the 2nd group is a biconcave lens, and the 3rd group is a biconvex lens; and the whole system consists of the three elements in the three groups. Inequalities I and II hold, where (f) is the focal length of the whole system and f_j ($j=1-3$) the focal length of the (j)th lens counted from the object side.

$$0.65 < f_1/f < 1.05$$

II

Further, the image-side surface of the 3rd group is the aspherical surface which has the cone constant k_7 , which is represented by an inequality III. Consequently, the small-sized, high-performance triplet lens for photography which has long back focus, includes an exit pupil separately from the image plane, and provides a wide picture plane and is bright is obtained.

$$-1.2 < k_7 < -0.8$$

III

LEGAL STATUS

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CLAIMS

[Claim(s)]

[Claim 1] It goes to an image side of drawing prefaced at a body side from the above-mentioned drawing side at an image side. One by one It comes to allot the 1st thru/or the 3rd group. A biconvex lens and the 2nd group the 1st group A biconcave lens, When the 3rd group is a three three groups configuration which is a biconvex lens, a focal distance of the whole system is counted from an f and body side and a focal distance of the j-th lens is set to f_j ($j=1-3$), These are conditions (1-1). $-0.53 < f_2/f < -0.38$ (1-2) $0.65 < f_1/f_3 < 1.05$ are satisfied. the image side of the 3rd group — cone constant: — the aspheric surface which has K_7 — it is — the above-mentioned cone constant: K_7 (1-3) $-1.2 < K_7 <$ — a triplet lens for photography characterized by being in the range of -0.8 .

[Claim 2] It goes to an image side of drawing prefaced at a body side from the above-mentioned drawing side at an image side. One by one It comes to allot the 1st thru/or the 3rd group. A biconvex lens and the 2nd group the 1st group A biconcave lens, When the 3rd group is a three three groups configuration which is a biconvex lens, a focal distance of the whole system is counted from an f and body side and a focal distance of the j-th lens is set to f_j ($j=1-3$), These are conditions (2-1). $-0.43 < f_2/f < -0.33$ (2-2) $0.65 < f_1/f_3 < 0.85$ are satisfied. The image side of the 1st group and the image side of the 3rd group are the aspheric surfaces which have cone constant: K_3 and K_7 , respectively, and the above-mentioned cone constant: K_3 and K_7 . (2-3) $0 < K_3 < 10$ (2-4) A triplet lens for photography characterized by being in the range of $-1.7 < K_7 < -1.0$.

[Claim 3] It goes to an image side of drawing prefaced at a body side from the above-mentioned drawing side at an image side. One by one It comes to allot the 1st thru/or the 3rd group. A biconvex lens and the 2nd group the 1st group A biconcave lens, When the 3rd group is a three three groups configuration which is a biconvex lens, a focal distance of the whole system is counted from an f and body side and a focal distance of the j-th lens is set to f_j ($j=1-3$), These are conditions (3-1). $-0.45 < f_2/f < -0.37$ (3-2) $0.67 < f_1/f_3 < 0.9$ are satisfied. The body side of the 2nd group and the image side of the 3rd group are the aspheric surfaces which have cone constant: K_4 and K_7 , respectively. The above-mentioned cone constant: K_4 and K_7 (3-3) $-1.5 < K_4 < 0$ (3-4) A triplet lens for photography characterized by being in the range of $-4.0 < K_7 < -1.0$.

[Claim 4] It goes to an image side of drawing prefaced at a body side from the above-mentioned drawing side at an image side. One by one It comes to allot the 1st thru/or the 3rd group. A biconvex lens and the 2nd group the 1st group A biconcave lens, When the 3rd group is a three three groups configuration which is a biconvex lens, a focal distance of the whole system is counted from an f and body side and a focal distance of the j-th lens is set to f_j ($j=1-3$), These are conditions (4-1). $-0.45 < f_2/f < -0.35$ (4-2) $0.75 < f_1/f_3 < 1.0$ are satisfied. The image side of the 2nd group and the image side of the 3rd group are cone constant: K_5 and the aspheric surface which has K_7 , respectively, and the above-mentioned cone constant: K_5 and K_7 . (4-3) $-0.5 < K_5 < 0$ (4-4) A triplet lens for photography characterized by being in the range of $-2.0 < K_7 < -1.0$.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention relates to the triplet lens for photography. This invention can be used suitable for a video camera or a steel video camera.

[0002]

[Description of the Prior Art] In a video camera or a steel video camera, the image formation side by the taking lens is a solid state image pickup device, the size of the light-receiving side is small as compared with the light-receiving side of the silver halide film in a film photo camera, and the focal distance of a taking lens will also become short.

[0003] In one side, in a video camera, a steel video camera, etc., in order to arrange the low pass filter for color moire prevention, the infrared light cutoff filter for amending the spectral sensitivity of a solid state image pickup device, etc. and to arrange these reasonable between a taking lens and a solid state image pickup device, it is necessary to secure the back focus of a taking lens somewhat greatly.

[0004] Moreover, these days, the micro lens of a convex is formed in the light-receiving side of each photo detector, and the solid state image pickup device which meant the increment in the amount of incident light to each photo detector is also put in practical use. In such a solid state image pickup device, if the beam of light which carries out incidence to a photo detector inclines greatly to a micro-lens optical axis, the situation which will not carry out incidence to "KERARE" ***** by the opening of a micro lens will arise. It is easy to be generated as it separates from the optical axis of a taking lens, and this inclination will cause the result which promotes the lack of the quantity of light of an image periphery as compared with an image core, if this situation arises. In order to avoid such a problem, it is necessary to carry out incidence of the incident ray to a solid state image pickup device at the angle near a light-receiving side normal if possible. For this reason, as for the exit pupil of a taking lens, it is desirable that it is distant from the image surface if possible.

[0005] Moreover, the miniaturization is always requested from the video camera or the steel video camera, and the thing of a triplet mold advantageous to a miniaturization is widely used as a taking lens from the former.

[0006] however, the taking lens of the triplet mold known from the former -- " -- a long back focus -- having -- an exit pupil -- from the image surface -- separating -- in addition -- and the thing of an extensive field angle and the diameter of macrostomia is realized -- " -- that is very difficult.

[0007]

[Problem(s) to be Solved by the Invention] this invention is made in view of the situation like the above -- having -- a back focus -- long -- an exit pupil -- from the image surface -- separating -- **** -- half -- it is about field angle:25 degree and an extensive field angle, and it is as bright as F/No=2.8, and is small, and aims at offer of the triplet lens for photography of high performance.

[0008]

[Means for Solving the Problem] a triplet lens for photography of this invention is indicated to be

also the lens of claims 1-4 to drawing 1 -- as -- " -- it was prefaced at a body side -- extracting -- an image side of 0 -- an image side from a drawing 0 side -- going -- one by one -- the 1st group 1 thru/or the 3rd group 3 -- allotting -- " -- it becomes. The 1st group 1 is [a biconcave lens and the 3rd group 3 of a biconvex lens and the 2nd group 2] biconvex lenses, therefore the whole system is a three three groups configuration. Moreover, a triplet lens for photography of claims 1-4 is common also in a point which adopted the aspheric surface as one or more lens sides.

[0009] For a triplet lens for photography of claim 1, when counting a focal distance of the whole system from an f and body side and setting a focal distance of the j-th lens to f_j ($j=1-3$) in the above-mentioned lens configuration, these are conditions (1-1). $-0.53 < f_2/f < -0.38$ (1-2) $0.65 < f_1/f_3 < 1.05$ are satisfied. Moreover, the image side of the 3rd group is the aspheric surface which has cone constant:K7, and these cone constant:K7. (1-3) It is in the range of $-1.2 < K7 < -0.8$.

[0010] For a triplet lens for photography of claim 2, in the above-mentioned lens configuration, it counts from a focal distance:f [of the above-mentioned whole system], and body side, and focal distance: f_j ($j=1-3$) of the j-th lens is conditions (2-1). $-0.43 < f_2/f < -0.33$ (2-2) $0.65 < f_1/f_3 < 0.85$ are satisfied. Moreover, the image side of the 1st group and the image side of the 3rd group are the aspheric surfaces which have cone constant:K3 and K7, respectively, and these cone constant:K3 and K7. (2-3) $0 < K3 < 10$ (2-4) It is in the range of $-1.7 < K7 < -1.0$.

[0011] a triplet lens for photography of claim 3 -- the above-mentioned lens configuration -- setting -- above-mentioned focal distance: -- f and f_j ($j=1-3$) -- conditions (3-1) $-0.45 < f_2/f < -0.37$ (3-2) $0.67 < f_1/f_3 < 0.9$ are satisfied. Moreover, the body side of the 2nd group and the image side of the 3rd group are the aspheric surfaces which have cone constant:K4 and K7, respectively, and these cone constant:K4 and K7. (3-3) $-1.5 < K4 < 0$ (3-4) It is in the range of $-4.0 < K7 < -1.0$.

[0012] a triplet lens for photography of claim 4 -- the above-mentioned lens configuration -- setting -- above-mentioned focal distance: -- f and f_j ($j=1-3$) -- conditions (4-1) $-0.45 < f_2/f < -0.35$ (4-2) $0.75 < f_1/f_3 < 1.0$ are satisfied. Moreover, the image side of the 2nd group and the image side of the 3rd group are cone constant:K5 and the aspheric surface which has K7, respectively, and these cone constant:K5 and K7. (4-3) $-0.5 < K5 < 0$ (4-4) It is in the range of $-2.0 < K7 < -1.0$.

[0013]

[Function] As mentioned above, with the triplet lens for photography of this invention, it is the so-called "before drawing die" as which drawing was prefaced [1st] at the body side, and the exit pupil is separated from the image surface by prefacing drawing in this way.

[0014] With positive, negative, and a positive lens configuration, since positive power strong against the 3rd group also in order to keep away an exit pupil from the image surface is needed also when securing a back focus, the negative big power which balances with it is needed for the 2nd group which is the only negative lens.

[0015] Moreover, what "the negative power of the 2nd group is strengthened [a thing] for the positive power of the 1st group according to strength and it" is effective in decreasing the PETTSU bar sum, suppressing the astigmatic difference, and making *** of the image surface small.

[0016] Since it is such, strong negative power is needed for the 2nd group. So, in this invention, the 2nd group was used as the biconcave lens and that negative power is regulated conditions (1-1), (2-1), (3-1), and (4-1).

[0017] When the minimum of these conditions (1-1), (2-1), (3-1), and (4-1) is exceeded according to combination with the adoption gestalt of the aspheric surface in a lens, it becomes impossible to reconcile long-distance-izing from reservation of a back focus, and the image surface of an exit pupil, and reduction of the PETTSU bar sum. Moreover, it is difficult from the field of lens processing to give the strong negative power exceeding a maximum to the 2nd group, and since overamendment of spherical aberration, buildup of comatic aberration, etc. are produced, it is not desirable from the field of aberration to give such strong negative power by force to the 2nd group.

[0018] It is necessary to distribute with balance [power / positive to the 1st and 3rd group] sufficient for realizing "reservation of a back focus, and reduction of long-distance-izing from the image surface of an exit pupil, and the PETTSU bar sum" in the condition that the above-mentioned conditions (1-1), (2-1), (3-1), and (4-1) were satisfied. Conditions (1-2), (2-2), (3-2), and (4-2) regulate this power allocation.

[0019] If the minimum of these conditions (1-2), (2-2), (3-2), and (4-2) is exceeded according to combination with the adoption gestalt of the aspheric surface in a lens, reservation of a back focus will become difficult and it will also become difficult to fully keep away an exit pupil from the image surface. Moreover, if a maximum is exceeded, while the PETTSU bar sum becomes large and the image surface falls on a negative side, the astigmatic difference will increase.

[0020] As mentioned above, the location and number of the aspheric surfaces which are adopted although the lens configuration of the triplet lens for photography of claims 1-4 is the same differ from each other mutually, and the ranges of condition parameter: f_2/f_1 [f and]/ f_3 differ by as which lens side the aspheric surface is adopted.

[0021] Like the triplet lens for photography of claim 1, when adopting the aspheric surface as the image side of the 3rd group, the high image formation engine performance can be secured by making the cone constant: K_7 into the range of inequality (1-3).

[0022] Like the triplet lens for photography of claim 2, when making the image side of the 1st group, and the image side of the 3rd group into the aspheric surface, the high image formation engine performance can be secured by making cone constant: K_3 of these aspheric surfaces, and K_7 into inequality (2-3) and the range of (2-4).

[0023] Like the triplet lens for photography of claim 3, when making the body side of the 2nd group, and the image side of the 3rd group into the aspheric surface, the high image formation engine performance can be secured by making cone constant: K_4 of these aspheric surfaces, and K_7 into inequality (3-3) and the range of (3-4).

[0024] Similarly, like the triplet lens for photography of claim 4, when making the image side of the 2nd group, and the image side of the 3rd group into the aspheric surface, the high image formation engine performance can be secured by making cone constant: K_5 of these aspheric surfaces, and K_7 into inequality (4-3) and the range of (4-4).

[0025]

[Example] It gives three examples at a time to below for every triplet lens for photography of each claim. In each example, as shown in drawing 1, plane parallel plate A is inserted between the triplet lens for photography, and the image surface. This plane parallel plate A replaces the cover glass of the low pass filter mentioned above, an infrared cutoff filter, and also a solid state image pickup device etc. as "being an equivalent plane parallel plate optically."

[0026] Each example is counted from a body side. The radius of curvature of the i-th field (the field of drawing 0 and the field of plane parallel plate A are included) r_i ($i=1-9$), The spacing on the i-th and the i+1st optical axis of a field is counted from a d_i ($i=1-8$) and body side, and the refractive index and the Abbe number of the j-th lens and plane parallel plate A are expressed with n_j and n_{uj} (it is $j=4$ to $j=1-3$ and a plane parallel plate to a lens), respectively. Furthermore, f counts the synthetic focal distance of the whole system, and f_j from a body side, in a back focus and AP, the distance between the image surface and an exit pupil and F/No express brightness, and omega expresses [the focal distance of the j-th lens, and BF] a half-field angle (unit: degree).

[0027] The "aspheric surface" like common knowledge When setting the amount of gaps from H and the reference spherical surface (radius of curvature is the spherical surface of R) to X and setting [the radius of curvature on an optical axis / R and the height from an optical axis] a cone constant and the 4th aspheric surface coefficient [6th / 8th / 10th] to A, B, C, and D for K, respectively, $X= [(1/R) H^2 / \{1+\sqrt{Y}\}] +$ It is the curved surface expressed with $A=H^4+B-H^6+C-H^8+D-H^10$ and the formula which becomes $Y=1-(1+K)(1/R)H^2$. The mark in this formula: \sqrt{Y} expresses the square root of Y. If the post of the aspheric surface in each example is taken, cone constant: K , high order aspheric surface coefficient: A , and B , C and D are given, and a configuration is specified. In addition, [E-numeric character] of a high order aspheric surface coefficient on display expresses a exponentiation. For example, if it is with [E-10], this will mean

[1/1010] and will multiply the number which has this number before that by it.

[0028] Example 1f=9.270mm, F/No=2.8, omega= 25.1, BF=0.605f, AP=2.824fi ri di j nj nuj1 infinity (drawing) 2.81 2 6.279 1.79 1 1.88300 40.80 3 - 74.201 0.964 - 11.661 0.80 2 1.79442 23.94 5 5.697 1.07613.271 2.39 3 1.78497 48.69 7 - 7.806 2.578 infinity 2.824 1.51633 64.15 9 infinity.

[0029] The 7th page (image side of the 3rd group) of aspheric surface

K=-0.849842, A=4.44360E-4, B=-8.30943E-6, C= 7.59358E-7, value f2/f=-0.509 of the parameter of E-D=-3.964548 conditional expression, f1/f3=1.005 .

[0030] Example 2f=9.270mm, F/No=2.8, omega= 25.1, BF=0.567f, AP=2.828fi ri di j nj nuj1 infinity (drawing) 2.38 2 5.772 1.82 1 1.88357 40.23 3 - 27.719 0.694 - 9.423 0.80 2 1.77721 24.51 5 5.098 1.59612.798 2.49 3 1.75500 52.30 7 - 8.190 2.218 infinity 2.824 1.51633 64.15 9 infinity.

[0031] The 7th page (image side of the 3rd group) of aspheric surface

K=-1.179592, A=5.31822E-4, B=-1.89000E-5, C= 1.11919E-6, value f2/f=-0.448 of the parameter of E-D=-3.349118 conditional expression, f1/f3=0.796 .

[0032] Example 3f=9.271mm, F/No=2.8, omega= 25.1, BF=0.552f, AP=2.830fi ri di j nj nuj1 infinity (drawing) 2.52 2 5.913 2.00 1 1.88300 40.78 3 - 15.133 0.554 - 8.091 0.80 2 1.76182 26.55 5 4.883 1.62614.893 2.53 3 1.75500 52.33 7 - 8.127 2.088 infinity 2.824 1.51633 64.15 9 infinity.

[0033] The 7th page (image side of the 3rd group) of aspheric surface

K=-1.098173, A=4.97051E-4, B=-3.60179E-5, C= 2.10315E-6, value f2/f=-0.420 of the parameter of E-D=-6.557158 conditional expression, f1/f3=0.689 .

[0034] As mentioned above, examples 1-3 are examples of the triplet lens for photography of claim 1.

[0035] Example 4f=9.270mm, F/No=2.8, omega= 25.1, BF=0.562f, AP=2.830fi ri di j nj nuj1 infinity (drawing) 2.41 2 5.712 2.16 1 1.88657 37.49 3 - 11.510 0.474 - 5.620 0.80 2 1.76644 24.89 5 4.942 1.58613.344 2.48 3 1.75500 52.30 7 - 7.788 2.178 infinity 2.824 1.51633 64.15 9 infinity.

[0036] The 3rd page (image side of the 1st group) of aspheric surface

K= 4.486506, A=-3.35753E-4, and B= 2.01897E-5, C=-4.30823E-6, and D= 1.01451E-7 -- the 7th page (image side of the 3rd group)

K=-1.363965, A=5.69893E-4, B=-3.14335E-5, C= 1.75986E-6, value f2/f=-0.358 of the parameter of E-D=-4.870258 conditional expression, f1/f3=0.667 .

[0037] Example 5f=9.269mm, F/No=2.8, omega= 25.1, BF=0.544f, AP=3.353fi ri di j nj nuj1 infinity (drawing) 3.05 2 6.021 2.33 1 1.88621 37.78 3 - 14.631 0.494 - 7.201 0.80 2 1.77083 24.73 5 5.069 1.16612.981 3.25 3 1.75501 52.30 7 - 7.852 1.878 infinity 2.734 1.51633 64.15 9 infinity.

[0038] The 3rd page (image side of the 1st group) of aspheric surface

K= 2.089766 and A=-5.94156 -- E-5, B=-8.43512E-6, C=-9.08398E-7, and D= 5.23291E-9 -- the 7th page (image side of the 3rd group)

K=-1.182835, A=5.33784E-4, B=-3.70378E-5, C= 2.26895E-6, value f2/f=-0.405 of the parameter of E-D=-7.270378 conditional expression, f1/f3=0.732 .

[0039] Example 6f=9.269mm, F/No=2.8, omega= 25.1, BF=0.593f, AP=3.119fi ri di j nj nuj1 infinity (drawing) 2.85 2 6.320 2.60 1 1.88300 40.80 3 - 12.730 0.564 - 4.739 0.80 2 1.74077 27.76 5 5.662 1.04611.372 2.52 3 1.75500 52.32 7 - 7.041 2.338 infinity 2.734 1.51633 64.15 9 infinity.

[0040] The 3rd page (image side of the 1st group) of aspheric surface

K= 9.326034, A=-8.14405E-4, B=-2.34823E-5, C=-9.18003E-7, the D=-1.14142E-7 7th side (image side of the 3rd group)

K=-1.577683, A=7.52908E-4, B=-4.33452E-5, C= 3.53342E-6, value f2/f=-0.364 of the parameter of E-D=-1.073317 conditional expression, f1/f3=0.835 .

[0041] As mentioned above, examples 4-6 are examples of the triplet lens for photography of claim 2.

[0042] Example 7f=9.268mm, F/No=2.8, omega= 25.1, BF=0.555f, AP=2.819fi ri di j nj nuj1 infinity (drawing) 2.79 2 6.008 2.11 1 1.88361 40.19 3 - 15.754 0.584 - 7.832 0.80 2 1.75802 25.20 5 4.999 1.50613.749 2.35 3 1.75500 52.30 7 - 8.333 2.108 infinity 2.824 1.51633 64.15 9 infinity.

[0043] The 4th page (body side of the 2nd group) of aspheric surface

K=-0.264297 and A= 9.14227 -- E-5, B=-2.99017E-7, C=-8.71086E-7, and D= 1.28201E-7 -- the 7th page (image side of the 3rd group)

K=-1.358236, A=5.46094E-4, B=-3.81054E-5, C= 2.16126E-6, value f2/f=-0.423 of the parameter

of $E-D=-6.429228$ conditional expression, $f1/f3=0.716$.

[0044] Example $8f=9.270\text{mm}$, $F/\text{No}=2.8$, $\text{omega}=25.1$, $\text{BF}=0.560f$, $\text{AP}=2.833fi$ $\text{ri di j nj nuj1 infinity}$ (drawing) $2.33 2 6.164 2.21 1 1.88500 38.87 3 - 14.061 0.604 - 6.171 0.80 2 1.76532 24.93 5 5.503 1.61610.807 2.40 3 1.75500 52.30 7 -8.766 2.158 infinity 2.824 1.51633 64.15 9 infinity$.

[0045] The 4th page (body side of the 2nd group) of aspheric surface

$K=-1.003544$ and $A=6.42509E-4$ and $B=3.79643E-5$, $C=-1.46521E-5$, and $D=9.49483E-7$ -- the 7th page (image side of the 3rd group)

$K=-3.253979$, $A=7.32747E-4$, $B=-3.79460E-5$, $C=2.44217E-6$, value $f2/f=-0.398$ of the parameter of $E-D=-6.183428$ conditional expression, $f1/f3=0.754$.

[0046] Example $9f=9.271\text{mm}$, $F/\text{No}=2.8$, $\text{omega}=25.1$, $\text{BF}=0.582f$, $\text{AP}=2.834fi$ $\text{ri di j nj nuj1 infinity}$ (drawing) $2.00 2 6.087 1.73 1 1.88511 38.77 3 - 23.710 0.834 - 6.952 0.80 2 1.78306 24.31 5 5.929 1.6769.897 2.45 3 1.75500 52.30 7 -8.831 2.358 infinity 2.824 1.51633 64.15 9 infinity$.

[0047] The 4th page (body side of the 2nd group) of aspheric surface

$K=-1.375966$ and $A=6.70435E-4$ and $B=4.57522E-5$, $C=-1.91251E-5$, and $D=1.24887E-6$ -- the 7th page (image side of the 3rd group)

$K=-3.683206$, $A=7.56743E-4$, $B=-1.54254E-5$, $C=1.26382E-6$, value $f2/f=-0.429$ of the parameter of $E-D=-3.703558$ conditional expression, $f1/f3=0.859$.

[0048] As mentioned above, examples 7-9 are examples of the triplet lens for photography of claim 3.

[0049] Example $10f=9.270\text{mm}$, $F/\text{No}=2.8$, $\text{omega}=25.1$, $\text{BF}=0.571f$, $\text{AP}=2.831fi$ $\text{ri di j nj nuj1 infinity}$ (drawing) $2.23 2 5.855 1.82 1 1.88363 40.17 3 - 17.737 0.704 - 7.005 0.80 2 1.75445 25.34 5 4.716 1.526 11.074 2.61 3 1.75500 52.30 7 -7.996 2.258 infinity 2.824 1.51633 64.15 9 infinity$.

[0050] The 5th page (image side of the 2nd group) of aspheric surface

$K=-0.358071$, $A=-8.00504E-4$, $B=2.58198E-5$, $C=-1.56296E-6$, the $D=-2.70252E-8$ 7th side (image side of the 3rd group)

$K=-1.694931$, $A=6.57757E-4$, $B=-2.53411E-5$, $C=1.83091E-6$, value $f2/f=-0.392$ of the parameter of $E-D=-4.689298$ conditional expression, $f1/f3=0.791$.

[0051] Example $11f=9.266\text{mm}$, $F/\text{No}=2.8$, $\text{omega}=25.1$, $\text{BF}=0.548f$, $\text{AP}=3.264fi$ $\text{ri di j nj nuj1 infinity}$ (drawing) $2.93 2 6.116 2.10 1 1.88467 39.17 3 - 18.571 0.634 - 7.772 0.80 2 1.75508 25.32 5 4.813 1.046 10.467 3.49 3 1.75508 52.29 7 -8.106 1.908 infinity 2.734 1.51633 64.15 9 infinity$.

[0052] The 5th page (image side of the 2nd group) of aspheric surface

$K=-0.214777$, $A=-3.96225E-4$, $B=-1.37232E-5$, $C=-1.51361E-6$, $D=$ The $2.66553E-8$ 7th side (image side of the 3rd group)

$K=-1.542723$, $A=6.02826E-4$, $B=-3.18740E-5$, $C=2.33182E-6$, value $f2/f=-0.414$ of the parameter of $E-D=-6.015218$ conditional expression, $f1/f3=0.823$.

[0053] Example $12f=9.271\text{mm}$, $F/\text{No}=2.8$, $\text{omega}=25.1$, $\text{BF}=0.587f$, $\text{AP}=3.506fi$ $\text{ri di j nj nuj1 infinity}$ (drawing) $3.10 2 6.438 1.89 1 1.88300 40.80 3 - 22.808 0.844 - 7.549 0.80 2 1.73438 26.17 5 4.865 0.966 10.119 3.10 3 1.75500 52.30 7 -7.561 2.278 infinity 2.734 1.51633 64.15 9 infinity$.

[0054] The 5th page (image side of the 2nd group) of aspheric surface

$K=-0.371889$, $A=-8.04256E-4$, and $B=2.53055E-5$, $C=-7.37685E-6$, and $D=4.07960E-7$ -- the 7th page (image side of the 3rd group)

$K=-1.482875$, $A=6.18740E-4$, $B=-2.37491E-5$, $C=$ Value $f2/f=-0.423$ of the parameter of $E-2.28422E-6$ and $D=-5.887968$ conditional expression, $f1/f3=0.946$.

[0055] As mentioned above, examples 10-12 are examples of the triplet lens for photography of claim 4.

[0056] Aberration drawing about examples 1-12 is shown in drawing 2 thru/or drawing 13 . Sign ***** in these aberration drawings expresses d, C, and an F line, respectively. The continuous line and dashed line in drawing of spherical aberration express spherical aberration and sine condition, respectively, the continuous line in drawing of astigmatism expresses a sagittal ray, and a dashed line expresses a meridional beam of light. Aberration is amended good and, as for each triplet lens for photography of each claim of this invention, each example has the high image formation engine performance.

[0057]

[Effect of the Invention] As mentioned above, according to this invention, the new triplet lens for

photography can be offered. the triplet lens for photography of this invention -- the configuration like the above -- F/No=2.8 -- bright -- the diameter of macrostomia -- it is -- half-field angle: -- an angle with the incident ray near [are about 25 degrees and a wide angle, and it is small, is highly efficient, and / an image sensor light-receiving side] a normal to a solid state image pickup device -- having -- in addition -- and it has the big back focus. Therefore, it is suitable as a taking lens of a video camera or a still video camera.

[Translation done.]

*** NOTICES ***

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1. This document has been translated by computer. So the translation may not reflect the original precisely.
- 2.**** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS**[Brief Description of the Drawings]**

[Drawing 1] It is drawing showing the lens configuration of the triplet lens for photography of this invention.

[Drawing 2] It is aberration drawing about an example 1.

[Drawing 3] It is aberration drawing about an example 2.

[Drawing 4] It is aberration drawing about an example 3.

[Drawing 5] It is aberration drawing about an example 4.

[Drawing 6] It is aberration drawing about an example 5.

[Drawing 7] It is aberration drawing about an example 6.

[Drawing 8] It is aberration drawing about an example 7.

[Drawing 9] It is aberration drawing about an example 8.

[Drawing 10] It is aberration drawing about an example 9.

[Drawing 11] It is aberration drawing about an example 10.

[Drawing 12] It is aberration drawing about an example 11.

[Drawing 13] It is aberration drawing about an example 12.

[Translation done.]



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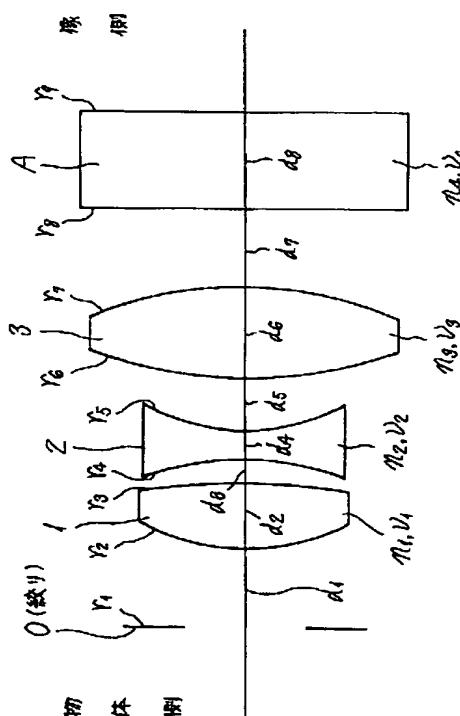
審査請求 未請求 請求項の数4(全21頁)

(54)【発明の名称】撮影用トリプレットレンズ

(57)【要約】

【目的】バックフォーカスが長く、射出瞳が像面から離れており、半画角:25度程度と広画角で、 $F/N = 2.8$ と明るく、且つ小型で高性能の撮影用トリプレットレンズを実現する。

【構成】物体側に前置された絞り0の像側に、絞り0側から像側に向かって順次、第1群1ないし第3群3を配してなる。第1群1は両凸レンズ、第2群2は両凹レンズ、第3群3は両凸レンズである3群3枚構成であり、全系の焦点距離を f 、物体側から数えて第j番目のレンズの焦点距離を f_j ($j = 1 \sim 3$)とするとき、条件パラメーター: f_2/f , f_1/f_3 が所定の範囲内にあり、第3群の像側面を含む1以上のレンズ面が、所定範囲の円錐定数を持つ非球面として形成される。



【特許請求の範囲】

【請求項1】物体側に前置された絞りの像側に、上記絞り側から像側に向かって順次、第1ないし第3群を配してなり、

第1群は両凸レンズ、第2群は両凹レンズ、第3群は両凸レンズである3群3枚構成であり、

全系の焦点距離を f 、物体側から数えて第 j 番目のレンズの焦点距離を f_j ($j = 1 \sim 3$) とするとき、これらが条件

$$(1-1) \quad -0.53 < f_2/f < -0.38$$

$$(1-2) \quad 0.65 < f_1/f_3 < 1.05$$

を満足し、

第3群の像側面が円錐定数: K_7 を有する非球面であり、上記円錐定数: K_7 が

$$(1-3) \quad -1.2 < K_7 < -0.8$$

の範囲にあることを特徴とする、撮影用トリプレットレンズ。

【請求項2】物体側に前置された絞りの像側に、上記絞り側から像側に向かって順次、第1ないし第3群を配してなり、

第1群は両凸レンズ、第2群は両凹レンズ、第3群は両凸レンズである3群3枚構成であり、

全系の焦点距離を f 、物体側から数えて第 j 番目のレンズの焦点距離を f_j ($j = 1 \sim 3$) とするとき、これらが条件

$$(2-1) \quad -0.43 < f_2/f < -0.33$$

$$(2-2) \quad 0.65 < f_1/f_3 < 0.85$$

を満足し、

第1群の像側面および第3群の像側面が、それぞれ円錐定数: K_3 , K_7 を有する非球面であり、上記円錐定数: K_3 , K_7 が

$$(2-3) \quad 0 < K_3 < 1.0$$

$$(2-4) \quad -1.7 < K_7 < -1.0$$

の範囲にあることを特徴とする、撮影用トリプレットレンズ。

【請求項3】物体側に前置された絞りの像側に、上記絞り側から像側に向かって順次、第1ないし第3群を配してなり、

第1群は両凸レンズ、第2群は両凹レンズ、第3群は両凸レンズである3群3枚構成であり、

全系の焦点距離を f 、物体側から数えて第 j 番目のレンズの焦点距離を f_j ($j = 1 \sim 3$) とするとき、これらが条件

$$(3-1) \quad -0.45 < f_2/f < -0.37$$

$$(3-2) \quad 0.67 < f_1/f_3 < 0.9$$

を満足し、

第2群の物体側面および第3群の像側面が、それぞれ円錐定数: K_4 , K_7 を有する非球面であり、上記円錐定数: K_4 , K_7 が

$$(3-3) \quad -1.5 < K_4 < 0$$

$$(3-4) \quad -4.0 < K_7 < -1.0$$

の範囲にあることを特徴とする、撮影用トリプレットレンズ。

【請求項4】物体側に前置された絞りの像側に、上記絞り側から像側に向かって順次、第1ないし第3群を配してなり、

第1群は両凸レンズ、第2群は両凹レンズ、第3群は両凸レンズである3群3枚構成であり、

全系の焦点距離を f 、物体側から数えて第 j 番目のレンズの焦点距離を f_j ($j = 1 \sim 3$) とするとき、これらが条件

$$(4-1) \quad -0.45 < f_2/f < -0.35$$

$$(4-2) \quad 0.75 < f_1/f_3 < 1.0$$

を満足し、

第2群の像側面および第3群の像側面が、それぞれ円錐定数: K_5 , K_7 を有する非球面であり、上記円錐定数: K_5 , K_7 が

$$(4-3) \quad -0.5 < K_5 < 0$$

$$(4-4) \quad -2.0 < K_7 < -1.0$$

の範囲にあることを特徴とする、撮影用トリプレットレンズ。

【発明の詳細な説明】

【0001】

【産業上の利用分野】この発明は撮影用トリプレットレンズに関する。この発明は、ビデオカメラやスチールビデオカメラに好適に利用できる。

【0002】

【従来の技術】ビデオカメラやスチールビデオカメラでは、撮影レンズによる結像面は固体撮像素子であり、その受光面の寸法は銀塩写真カメラにおける銀塩フィルムの受光面に比して小さく、撮影レンズの焦点距離も短いものとなる。

【0003】一方において、ビデオカメラやスチールビデオカメラ等においては、撮影レンズと固体撮像素子の間に、色モアレ防止用のローパスフィルターや、固体撮像素子の分光感度を補正するための赤外光遮断フィルター等を配備する必要があり、これらを無理なく配備するには、撮影レンズのバックフォーカスをある程度大きく確保する必要がある。

【0004】また近来、各受光素子の受光面に凸のマイクロレンズを形成し、各受光素子への入射光量の増加を意図した固体撮像素子も実用化されている。このような固体撮像素子では、受光素子に入射する光線がマイクロレンズ光軸に対して大きく傾くと、マイクロレンズの開口により「ケラレ」て受光素子に入射しなくなる事態が生じる。この傾向は撮影レンズの光軸から離れるに従って生じ易く、かかる事態が生ずると画像中心部に比して画像周辺部の光量不足を助長する結果を招く。このような問題を避けるためには、固体撮像素子への入射光線を、なるべく受光面法線に近い角度で入射させる必要が

ある。このために撮影レンズの射出瞳は像面からなるべく離れていることが望ましい。

【0005】またビデオカメラやスチールビデオカメラには常に小型化が要請されており、従来から撮影レンズとして、小型化に有利なトリプレット型のものが広く用いられている。

【0006】しかし、従来から知られているトリプレット型の撮影レンズで「長いバックフォーカスを有し、射出瞳が像面から離れ、なおかつ広画角・大口径のものを実現する」のは、極めて困難である。

【0007】

【発明が解決しようとする課題】この発明は、上記の如き事情に鑑みてなされたものであって、バックフォーカスが長く、射出瞳が像面から離れており、半画角：25度程度と広画角で、 $F/N = 2.8$ と明るく、且つ小型で高性能の撮影用トリプレットレンズの提供を目的とする。

【0008】

【課題を解決するための手段】この発明の撮影用トリプレットレンズは、請求項1～4のレンズとも、図1に示すように「物体側に前置された絞り0の像側に、絞り0側から像側に向かって順次、第1群1ないし第3群3を配して」なる。第1群1は両凸レンズ、第2群2は両凹レンズ、第3群3は両凸レンズであり、従って全系は3群3枚構成である。また、請求項1～4の撮影用トリプレットレンズは、1以上のレンズ面に非球面を採用した点においても共通している。

【0009】請求項1の撮影用トリプレットレンズは、上記のレンズ構成において、全系の焦点距離を f 、物体側から数えて第 j 番目のレンズの焦点距離を f_j （ $j = 1 \sim 3$ ）とするとき、これらが条件

$$(1-1) \quad -0.53 < f_2/f < -0.38$$

$$(1-2) \quad 0.65 < f_1/f_3 < 1.05$$

を満足する。また、第3群の像側面が円錐定数： K_7 を有する非球面であり、この円錐定数： K_7 は

$$(1-3) \quad -1.2 < K_7 < -0.8$$

の範囲にある。

【0010】請求項2の撮影用トリプレットレンズは、上記レンズ構成において、上記全系の焦点距離： f 、物体側から数えて第 j 番目のレンズの焦点距離： f_j （ $j = 1 \sim 3$ ）が条件

$$(2-1) \quad -0.43 < f_2/f < -0.33$$

$$(2-2) \quad 0.65 < f_1/f_3 < 0.85$$

を満足する。また、第1群の像側面および第3群の像側面が、それぞれ円錐定数： K_3 、 K_7 を有する非球面であり、これら円錐定数： K_3 、 K_7 は

$$(2-3) \quad 0 < K_3 < 1.0$$

$$(2-4) \quad -1.7 < K_7 < -1.0$$

の範囲にある。

【0011】請求項3の撮影用トリプレットレンズは、

上記レンズ構成において、上記焦点距離： f 、 f_j （ $j = 1 \sim 3$ ）が条件

$$(3-1) \quad -0.45 < f_2/f < -0.37$$

$$(3-2) \quad 0.67 < f_1/f_3 < 0.9$$

を満足する。また、第2群の物体側面および第3群の像側面が、それぞれ円錐定数： K_4 、 K_7 を有する非球面であり、これら円錐定数： K_4 、 K_7 は

$$(3-3) \quad -1.5 < K_4 < 0$$

$$(3-4) \quad -4.0 < K_7 < -1.0$$

の範囲にある。

【0012】請求項4の撮影用トリプレットレンズは、上記のレンズ構成において、上記焦点距離： f 、 f_j （ $j = 1 \sim 3$ ）が条件

$$(4-1) \quad -0.45 < f_2/f < -0.35$$

$$(4-2) \quad 0.75 < f_1/f_3 < 1.0$$

を満足する。また、第2群の像側面および第3群の像側面が、それぞれ円錐定数： K_5 、 K_7 を有する非球面であり、これら円錐定数： K_5 、 K_7 は

$$(4-3) \quad -0.5 < K_5 < 0$$

$$(4-4) \quad -2.0 < K_7 < -1.0$$

の範囲にある。

【0013】

【作用】上記のように、この発明の撮影用トリプレットレンズでは、第1に絞りが物体側に前置された所謂「前絞り型」であり、このように絞りを前置することにより射出瞳を像面から離している。

【0014】正・負・正のレンズ構成では、バックフォーカスを確保する上でも、射出瞳を像面から遠ざけるためにも、第3群に強い正のパワーが必要となるため、唯一の負レンズである第2群には、それに釣り合う負の大きなパワーが必要となる。

【0015】また、ペツツバール和を減少させて非点隔差を抑え、像面の倒れを小さくするには「第1群の正のパワーを強め、それに応じて第2群の負のパワーを強める」ことが有効である。

【0016】このような理由から、第2群には強い負のパワーが必要となる。そこで、この発明では第2群を両凹レンズとし、その負のパワーを、条件（1-1）, (2-1), (3-1), (4-1)で規制している。

【0017】レンズ中における非球面の採用形態との組合せに応じて、これらの条件（1-1），（2-1），（3-1），（4-1）の下限を超えると、バックフォーカスの確保および射出瞳の像面からの遠距離化と、ペツツバール和の減少とを両立させることができなくなる。また、上限を超える強い負のパワーを第2群に与えることはレンズ加工の面から困難であり、無理にこのような強い負のパワーを第2群に与えることは、球面収差の補正過剰やコマ収差の増大等を生じるので収差の面からも好ましくない。

【0018】上記条件（1-1），（2-1），（3-

1) , (4-1) が満足された状態において「バックフォーカスの確保および射出瞳の像面からの遠距離化とペツツバール和の減少」を実現するには第1, 第3群に正のパワーをバランス良く配分する必要がある。条件(1-2), (2-2), (3-2), (4-2) は、このパワー配分を規制するものである。

【0019】レンズ中における非球面の採用形態との組合せに応じて、これらの条件(1-2), (2-2), (3-2), (4-2) の下限を超えると、バックフォーカスの確保が困難となり、射出瞳を像面から十分に遠ざけることも困難になる。また、上限を超えると、ペツツバール和が大きくなり像面が負の側に倒れるとともに非点隔差が増大する。

【0020】上記のように、請求項1~4の撮影用トリプレットレンズは、レンズ構成は同じであるが採用する非球面の位置と数とが互いに異なり、どのレンズ面に非球面を採用するかにより、条件パラメーター: f_2/f , f_1/f_3 の範囲が異なっている。

【0021】請求項1の撮影用トリプレットレンズのように、第3群の像側面に非球面を採用する場合、その円錐定数: K_7 を不等式(1-3)の範囲にすることにより高い結像性能を確保することができる。

【0022】請求項2の撮影用トリプレットレンズのように、第1群の像側面および第3群の像側面を非球面とする場合、これら非球面の円錐定数: K_3 , K_7 を、不等式(2-3), (2-4)の範囲とすることにより高い結像性能を確保できる。

【0023】請求項3の撮影用トリプレットレンズのように、第2群の物体側面および第3群の像側面を非球面とする場合、これら非球面の円錐定数: K_4 , K_7 を、不等式(3-3), (3-4)の範囲とすることにより高

$$X = [(1/R) H^2 / (1 + \sqrt{[Y]})] + A \cdot H^4 + B \cdot H^6 + C \cdot H^8 + D \cdot H^{10}, \quad Y = 1 - (1+K) (1/R)^2 H^2$$

なる式で表される曲面である。この式中の記号: $\sqrt{[Y]}$ はYの平方根を表す。各実施例中の非球面に就いては、円錐定数: Kと高次の非球面係数: A, B, C, Dを与えて形状を特定する。なお高次の非球面係数の表示中の [E-数字] はべき乗を表す。例えば [E-1

i	r_i	d_i
1	∞ (絞り)	2.81
2	6.279	1.79
3	-74.201	0.96
4	-11.661	0.80
5	5.697	1.07
6	13.271	2.39
7	-7.806	2.57
8	∞	2.82
9	∞	

【0029】非球面

第7面 (第3群の像側面)

い結像性能を確保できる。

【0024】同様に、請求項4の撮影用トリプレットレンズのように、第2群の像側面および第3群の像側面を非球面とする場合、これら非球面の円錐定数: K_5 , K_7 を、不等式(4-3), (4-4)の範囲とすることにより、高い結像性能を確保できる。

【0025】

【実施例】以下に、各請求項の撮影用トリプレットレンズごとに、3例づつ実施例を挙げる。各実施例において、図1に示すように平行平面ガラスAが撮影用トリプレットレンズと像面との間に挿入されている。この平行平面ガラスAは、前述したローパスフィルター、赤外線遮断フィルター、更には固体撮像素子のカバーガラス等を「光学的に等価な平行平面ガラス」として置き換えたものである。

【0026】各実施例とも、物体側から数えて第i番目の面(絞り0の面および平行平面ガラスAの面を含む)の曲率半径を r_i ($i = 1 \sim 9$)、第i番目と第i+1番目の面の光軸上の面間隔を d_i ($i = 1 \sim 8$)、物体側から数えて第j番目のレンズおよび平行平面ガラスAの屈折率およびアーベ数をそれぞれ、 n_j , v_j (レンズに対して $j = 1 \sim 3$ 、平行平面ガラスに対して $j = 4$) で表す。さらに f は全系の合成焦点距離、 f_j は物体側から数えて第j番目のレンズの焦点距離、 $B F$ はバックフォーカス、 $A P$ は像面と射出瞳との間の距離、 F/N は明るさ、 ω は半画角(単位:度)を表す。

【0027】「非球面」は周知の如く、光軸上の曲率半径を R 、光軸からの高さを H 、参照球面(曲率半径が R の球面)からのずれ量を X 、 K を円錐定数、4次、6次、8次、10次の非球面係数をそれぞれ A , B , C , D とするとき、

$$X = [(1/R) H^2 / (1 + \sqrt{[Y]})] +$$

$$A \cdot H^4 + B \cdot H^6 + C \cdot H^8 + D \cdot H^{10}, \quad Y = 1 - (1+K) (1/R)^2 H^2$$

0] とあれば、これは $[1/10^{10}]$ を意味し、この数がその前に有る数に乗せられるのである。

【0028】実施例1

$$f = 9.270 \text{ mm}, \quad F/N = 2.8, \quad \omega = 25.1, \quad B F = 0.605 f, \quad A P = 2.824 f$$

j	n_j	v_j
1	1.88300	40.80
2	1.79442	23.94
3	1.78497	48.69
4	1.51633	64.15

$$K = -0.849842, \quad A = 4.44360 E - 4, \quad B = -8.30943 E - 6, \quad C = 7.59358 E$$

$-7, D = -3.96454E-8$

条件式のパラメーターの値

$f_2/f = -0.509, f_1/f_3 = 1.005$

。

i	r_i	d_i	j	n_j	v_j
1	∞ (絞り)	2.38			
2	5.772	1.82	1	1.88357	40.23
3	-27.719	0.69			
4	-9.423	0.80	2	1.77721	24.51
5	5.098	1.59			
6	12.798	2.49	3	1.75500	52.30
7	-8.190	2.21			
8	∞	2.82	4	1.51633	64.15
9	∞				

【0031】非球面

第7面 (第3群の像側面)

$K = -1.179592, A = 5.31822E-4,$
 $B = -1.89000E-5, C = 1.11919E$
 $-6, D = -3.34911E-8$

条件式のパラメーターの値

i	r_i	d_i	j	n_j	v_j
1	∞ (絞り)	2.52			
2	5.913	2.00	1	1.88300	40.78
3	-15.133	0.55			
4	-8.091	0.80	2	1.76182	26.55
5	4.883	1.62			
6	14.893	2.53	3	1.75500	52.33
7	-8.127	2.08			
8	∞	2.82	4	1.51633	64.15
9	∞				

【0033】非球面

第7面 (第3群の像側面)

$K = -1.098173, A = 4.97051E-4,$
 $B = -3.60179E-5, C = 2.10315E$
 $-6, D = -6.55715E-8$

条件式のパラメーターの値

$f_2/f = -0.420, f_1/f_3 = 0.689$

i	r_i	d_i	j	n_j	v_j
1	∞ (絞り)	2.41			
2	5.712	2.16	1	1.88657	37.49
3	-11.510	0.47			
4	-5.620	0.80	2	1.76644	24.89
5	4.942	1.58			
6	13.344	2.48	3	1.75500	52.30
7	-7.788	2.17			
8	∞	2.82	4	1.51633	64.15
9	∞				

【0036】非球面

第3面 (第1群の像側面)

$K = 4.486506, A = -3.35753E-$

【0030】実施例2

$f = 9.270mm, F/N_o = 2.8, \omega = 25.$
 $1, BF = 0.567f, AP = 2.828f$

$f_2/f = -0.448, f_1/f_3 = 0.796$

【0032】実施例3

$f = 9.271mm, F/N_o = 2.8, \omega = 25.$
 $1, BF = 0.552f, AP = 2.830f$

【0034】以上、実施例1～3は請求項1の撮影用トリプレットレンズの実施例である。

【0035】実施例4

$f = 9.270mm, F/N_o = 2.8, \omega = 25.$
 $1, BF = 0.562f, AP = 2.830f$

$4, B = 2.01897E-5, C = -4.3082$

$3E-6, D = 1.01451E-7$

第7面 (第3群の像側面)

$K = -1.363965$, $A = 5.69893E-4$,
 $B = -3.14335E-5$, $C = 1.75986E-6$, $D = -4.87025E-8$

条件式のパラメーターの値

$$f_2/f = -0.358, f_1/f_3 = 0.667$$

i	r_i	d_i	j	n_j	v_j
1	∞ (絞り)	3.05			
2	6.021	2.33	1	1.88621	37.78
3	-14.631	0.49			
4	-7.201	0.80	2	1.77083	24.73
5	5.069	1.16			
6	12.981	3.25	3	1.75501	52.30
7	-7.852	1.87			
8	∞	2.73	4	1.51633	64.15
9	∞				

【0038】非球面

第3面 (第1群の像側面)

$K = 2.089766$, $A = -5.94156E-5$, $B = -8.43512E-6$, $C = -9.08398E-7$, $D = 5.23291E-9$

第7面 (第3群の像側面)

$K = -1.182835$, $A = 5.33784E-4$, $B = -3.70378E-5$, $C = 2.26895E$

i	r_i	d_i	j	n_j	v_j
1	∞ (絞り)	2.85			
2	6.320	2.60	1	1.88300	40.80
3	-12.730	0.56			
4	-4.739	0.80	2	1.74077	27.76
5	5.662	1.04			
6	11.372	2.52	3	1.75500	52.32
7	-7.041	2.33			
8	∞	2.73	4	1.51633	64.15
9	∞				

【0040】非球面

第3面 (第1群の像側面)

$K = 9.326034$, $A = -8.14405E-4$, $B = -2.34823E-5$, $C = -9.18003E-7$, $D = -1.14142E-7$

第7面 (第3群の像側面)

$K = -1.577683$, $A = 7.52908E-4$, $B = -4.33452E-5$, $C = 3.53342E-6$, $D = -1.07331E-7$

i	r_i	d_i	j	n_j	v_j
1	∞ (絞り)	2.79			
2	6.008	2.11	1	1.88361	40.19
3	-15.754	0.58			
4	-7.832	0.80	2	1.75802	25.20
5	4.999	1.50			
6	13.749	2.35	3	1.75500	52.30
7	-8.333	2.10			

【0037】実施例5

$f = 9.269mm$, $F/No = 2.8$, $\omega = 25$.
 1 , $BF = 0.544f$, $AP = 3.353f$

-6 , $D = -7.27037E-8$

条件式のパラメーターの値

$$f_2/f = -0.405, f_1/f_3 = 0.732$$

【0039】実施例6

$f = 9.269mm$, $F/No = 2.8$, $\omega = 25$.
 1 , $BF = 0.593f$, $AP = 3.119f$

条件式のパラメーターの値

$$f_2/f = -0.364, f_1/f_3 = 0.835$$

【0041】以上、実施例4～6は請求項2の撮影用トリプレットレンズの実施例である。

【0042】実施例7

$f = 9.268mm$, $F/No = 2.8$, $\omega = 25$.
 1 , $BF = 0.555f$, $AP = 2.819f$

8	∞	2. 82	4 1. 51633	64. 15
9	∞			

【0043】非球面

第4面(第2群の物体側面)

$K = -0.264297, A = 9.14227E-5, B = -2.99017E-7, C = -8.71086E-7, D = 1.28201E-7$

第7面(第3群の像側面)

$K = -1.358236, A = 5.46094E-4, B = -3.81054E-5, C = 2.16126E$

i	r_i	d_i	j	n_j	ν_j
1	∞ (絞り)	2. 33			
2	6. 164	2. 21	1	1. 88500	38. 87
3	-14. 061	0. 60			
4	-6. 171	0. 80	2	1. 76532	24. 93
5	5. 503	1. 61			
6	10. 807	2. 40	3	1. 75500	52. 30
7	-8. 766	2. 15			
8	∞	2. 82	4	1. 51633	64. 15
9	∞				

【0045】非球面

第4面(第2群の物体側面)

$K = -1.003544, A = 6.42509E-4, B = 3.79643E-5, C = -1.46521E-5, D = 9.49483E-7$

第7面(第3群の像側面)

$K = -3.253979, A = 7.32747E-4, B = -3.79460E-5, C = 2.44217E$

i	r_i	d_i	j	n_j	ν_j
1	∞ (絞り)	2. 00			
2	6. 087	1. 73	1	1. 88511	38. 77
3	-23. 710	0. 83			
4	-6. 952	0. 80	2	1. 78306	24. 31
5	5. 929	1. 67			
6	9. 897	2. 45	3	1. 75500	52. 30
7	-8. 831	2. 35			
8	∞	2. 82	4	1. 51633	64. 15
9	∞				

【0047】非球面

第4面(第2群の物体側面)

$K = -1.375966, A = 6.70435E-4, B = 4.57522E-5, C = -1.91251E-5, D = 1.24887E-6$

第7面(第3群の像側面)

$K = -3.683206, A = 7.56743E-4, B = -1.54254E-5, C = 1.26382E-6, D = -3.70355E-8$

i	r_i	d_i	j	n_j	ν_j
1	∞ (絞り)	2. 23			
2	5. 855	1. 82	1	1. 88363	40. 17

$-6, D = -6.42922E-8$

条件式のパラメーターの値

$f_2/f = -0.423, f_1/f_3 = 0.716$

【0044】実施例8

$f = 9.270mm, F/N_o = 2.8, \omega = 25.1, BF = 0.560f, AP = 2.833f$

$-6, D = -6.18342E-8$

条件式のパラメーターの値

$f_2/f = -0.398, f_1/f_3 = 0.754$

【0046】実施例9

$f = 9.271mm, F/N_o = 2.8, \omega = 25.1, BF = 0.582f, AP = 2.834f$

$j \quad n_j \quad \nu_j$

j	n_j	ν_j
1	1. 88511	38. 77
2	1. 78306	24. 31
3	1. 75500	52. 30
4	1. 51633	64. 15

条件式のパラメーターの値

$f_2/f = -0.429, f_1/f_3 = 0.859$

【0048】以上、実施例7～9は請求項3の撮影用トリプレットレンズの実施例である。

【0049】実施例10

$f = 9.270mm, F/N_o = 2.8, \omega = 25.1, BF = 0.571f, AP = 2.831f$

3	-17.737	0.70		
4	-7.005	0.80	2	1.75445 25.34
5	4.716	1.52		
6	11.074	2.61	3	1.75500 52.30
7	-7.996	2.25		
8	∞	2.82	4	1.51633 64.15
9	∞			

【0050】非球面

第5面(第2群の像側面)

$K = -0.358071, A = -8.00504E-4, B = 2.58198E-5, C = -1.56296E-6, D = -2.70252E-8$

第7面(第3群の像側面)

$K = -1.694931, A = 6.57757E-4, B = -2.53411E-5, C = 1.83091E$

i	r_i	d_i	j	n_j	ν_j
1	∞ (絞り)	2.93			
2	6.116	2.10	1	1.88467	39.17
3	-18.571	0.63			
4	-7.772	0.80	2	1.75508	25.32
5	4.813	1.04			
6	10.467	3.49	3	1.75508	52.29
7	-8.106	1.90			
8	∞	2.73	4	1.51633	64.15
9	∞				

【0052】非球面

第5面(第2群の像側面)

$K = -0.214777, A = -3.96225E-4, B = -1.37232E-5, C = -1.51361E-6, D = 2.66553E-8$

第7面(第3群の像側面)

$K = -1.542723, A = 6.02826E-4, B = -3.18740E-5, C = 2.33182E$

i	r_i	d_i	j	n_j	ν_j
1	∞ (絞り)	3.10			
2	6.438	1.89	1	1.88300	40.80
3	-22.808	0.84			
4	-7.549	0.80	2	1.73438	26.17
5	4.865	0.96			
6	10.119	3.10	3	1.75500	52.30
7	-7.561	2.27			
8	∞	2.73	4	1.51633	64.15
9	∞				

【0054】非球面

第5面(第2群の像側面)

$K = -0.371889, A = -8.04256E-4, B = 2.53055E-5, C = -7.37685E-6, D = 4.07960E-7$

第7面(第3群の像側面)

$K = -1.482875, A = 6.18740E-4,$

$-6, D = -4.68929E-8$

条件式のパラメーターの値

$f_2/f = -0.392, f_1/f_3 = 0.791$

【0051】実施例11

$f = 9.266mm, F/No = 2.8, \omega = 25.1, BF = 0.548f, AP = 3.264f$

$-6, D = -6.01521E-8$

条件式のパラメーターの値

$f_2/f = -0.414, f_1/f_3 = 0.823$

【0053】実施例12

$f = 9.271mm, F/No = 2.8, \omega = 25.1, BF = 0.587f, AP = 3.506f$

$B = -2.37491E-5, C = 2.28422E$

$-6, D = -5.88796E-8$

条件式のパラメーターの値

$f_2/f = -0.423, f_1/f_3 = 0.946$

【0055】以上、実施例10～12は請求項4の撮影用トリプレットレンズの実施例である。

【0056】図2乃至図13に、実施例1～12に関する収差図を示す。これらの収差図中の符号①②③はそれぞれd, C, F線をそれぞれ表す。球面収差の図における実線と破線は、それぞれ球面収差と正弦条件を表し、非点収差の図における実線はサジタル光線、破線はメリディオナル光線を表す。各実施例とも収差は良好に補正されており、この発明の各請求項の撮影用トリプレットレンズはいずれも高い結像性能を有する。

【0057】

【発明の効果】以上のように、この発明によれば新規な撮影用トリプレットレンズを提供できる。この発明の撮影用トリプレットレンズは上記の如き構成により、F/N_o = 2.8と明るく大口径で、半画角：25度程度と広角であり、且つ小型で高性能であり、固体撮像素子への入射光線が撮像素子受光面の法線に近い角度を持ち、尚且つ大きなバックフォーカスを有している。従って、ビデオカメラやスチールビデオカメラの撮影レンズとし

て好適である。

【図面の簡単な説明】

【図1】この発明の撮影用トリプレットレンズの構成を示す図である。

【図2】実施例1に関する収差図である。

【図3】実施例2に関する収差図である。

【図4】実施例3に関する収差図である。

【図5】実施例4に関する収差図である。

【図6】実施例5に関する収差図である。

【図7】実施例6に関する収差図である。

【図8】実施例7に関する収差図である。

【図9】実施例8に関する収差図である。

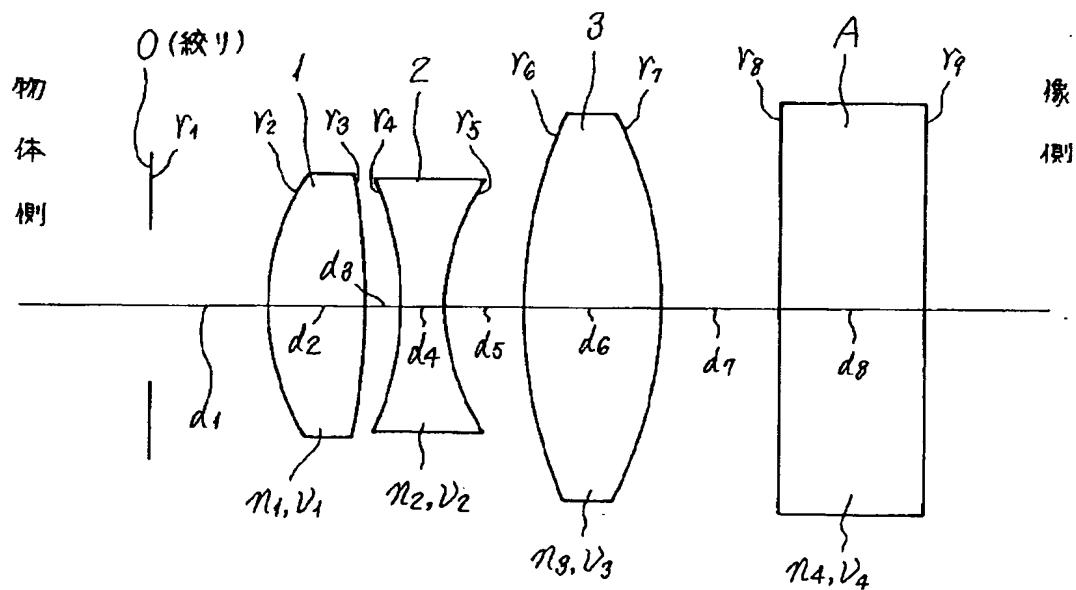
【図10】実施例9に関する収差図である。

【図11】実施例10に関する収差図である。

【図12】実施例11に関する収差図である。

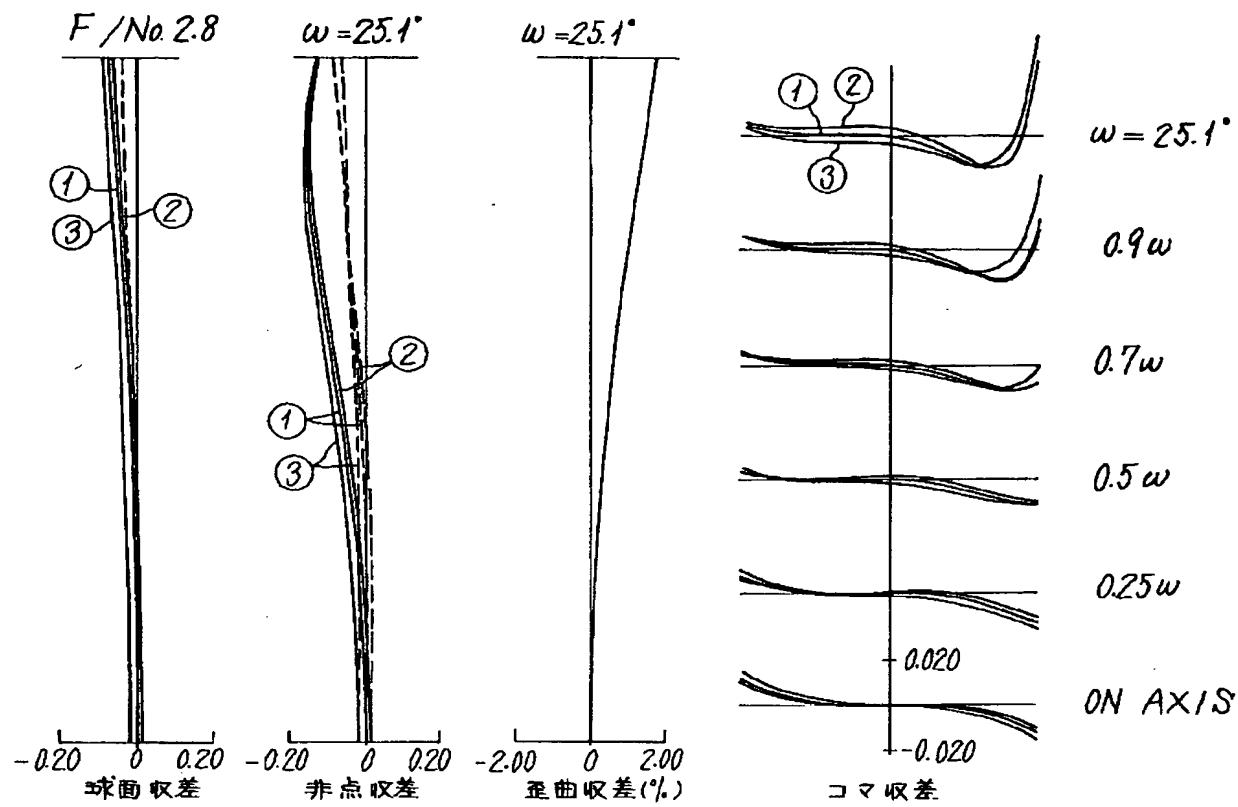
【図13】実施例12に関する収差図である。

【図1】



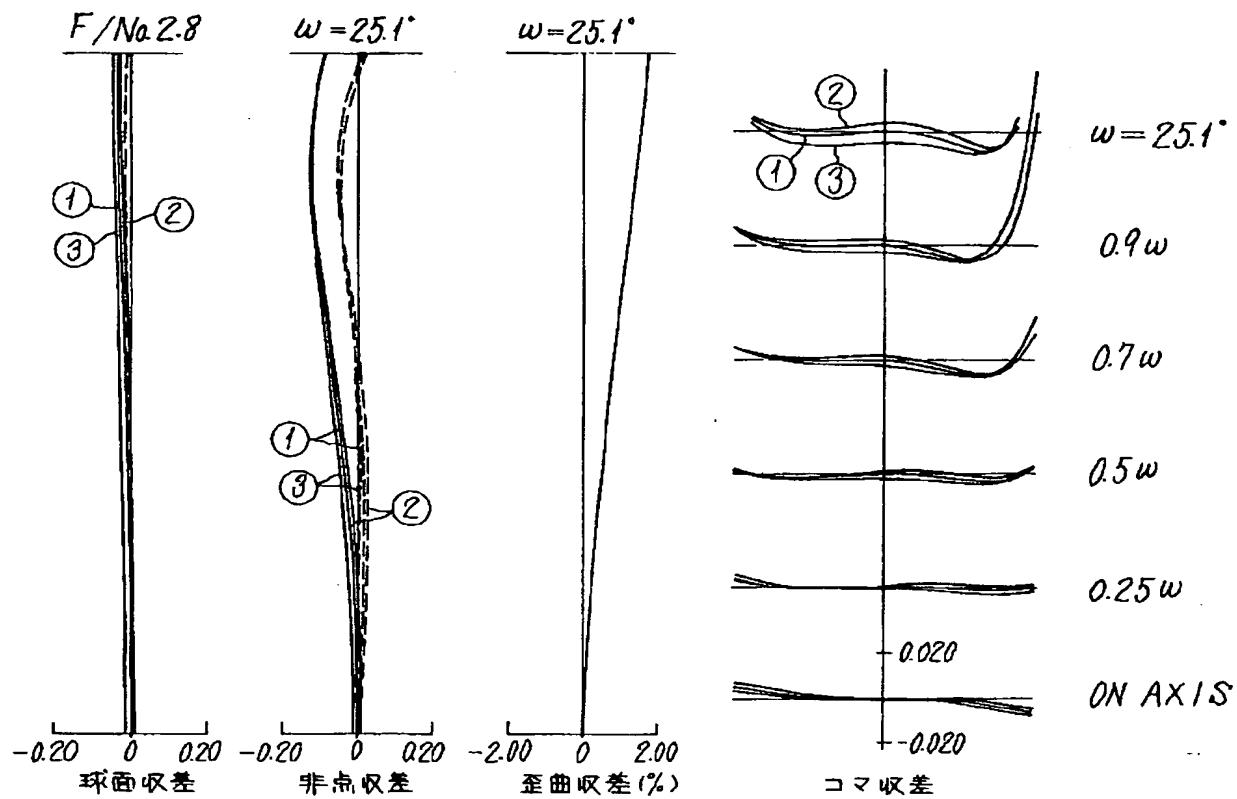
【図2】

(実施例1)



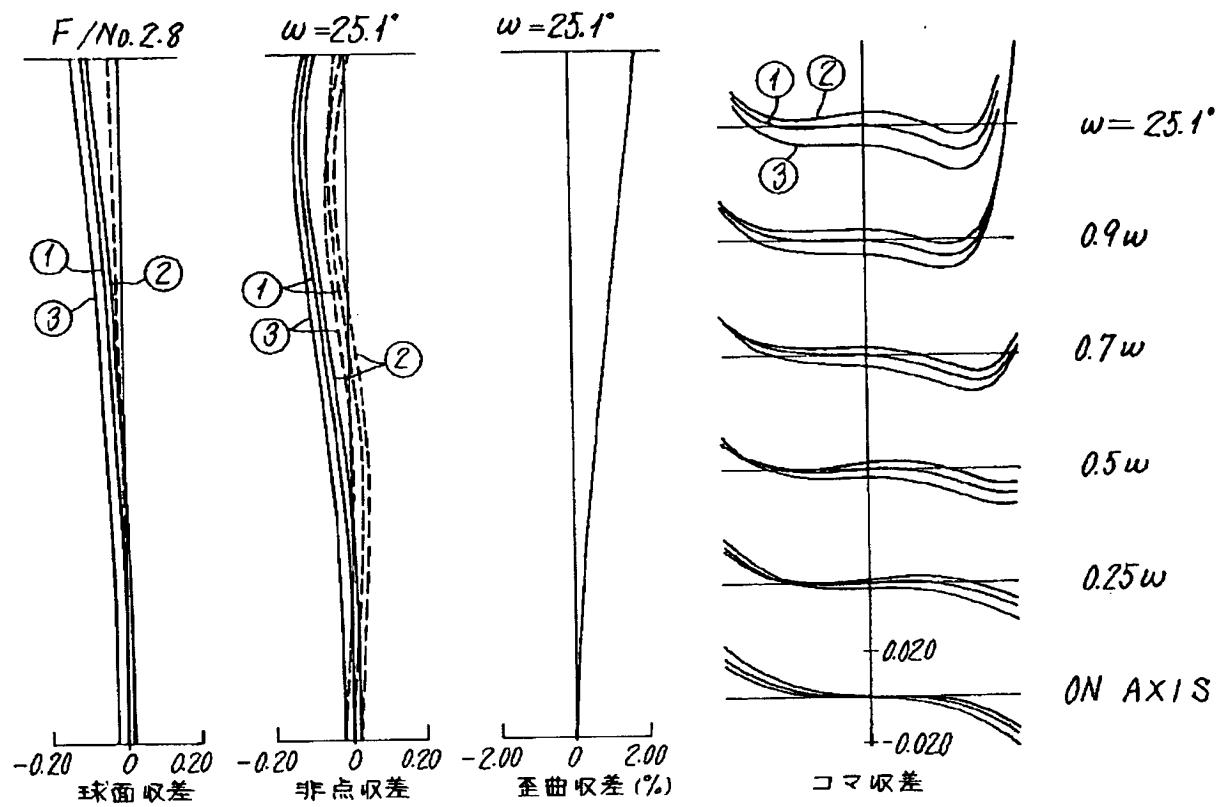
【図3】

(実施例2)



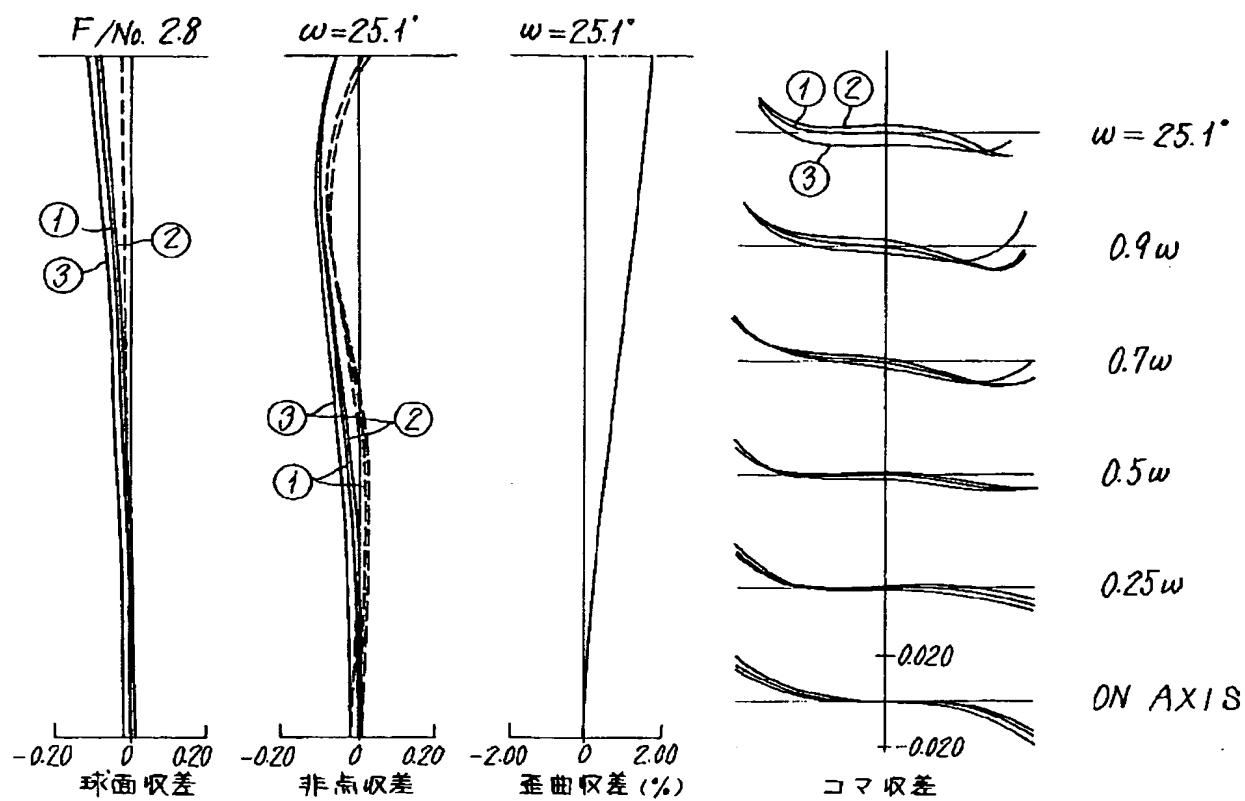
【図4】

(実施例3)



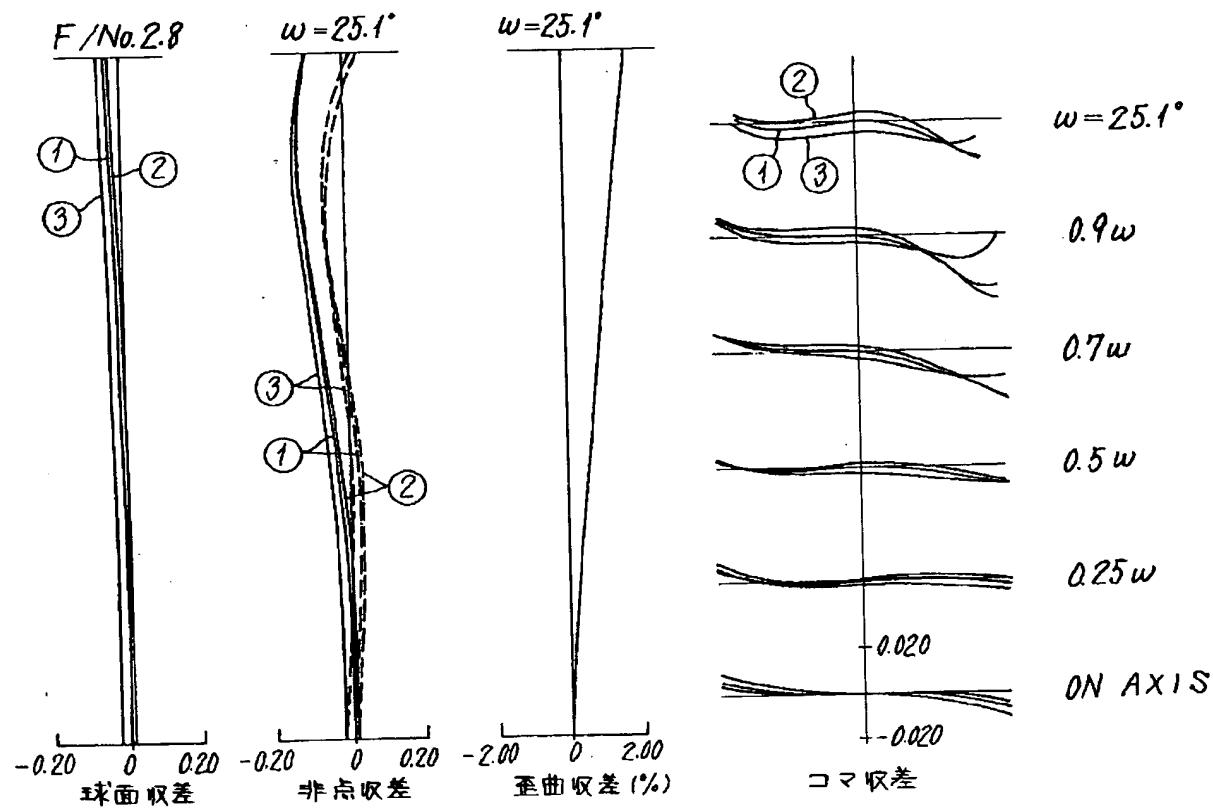
【図5】

(実施例4)



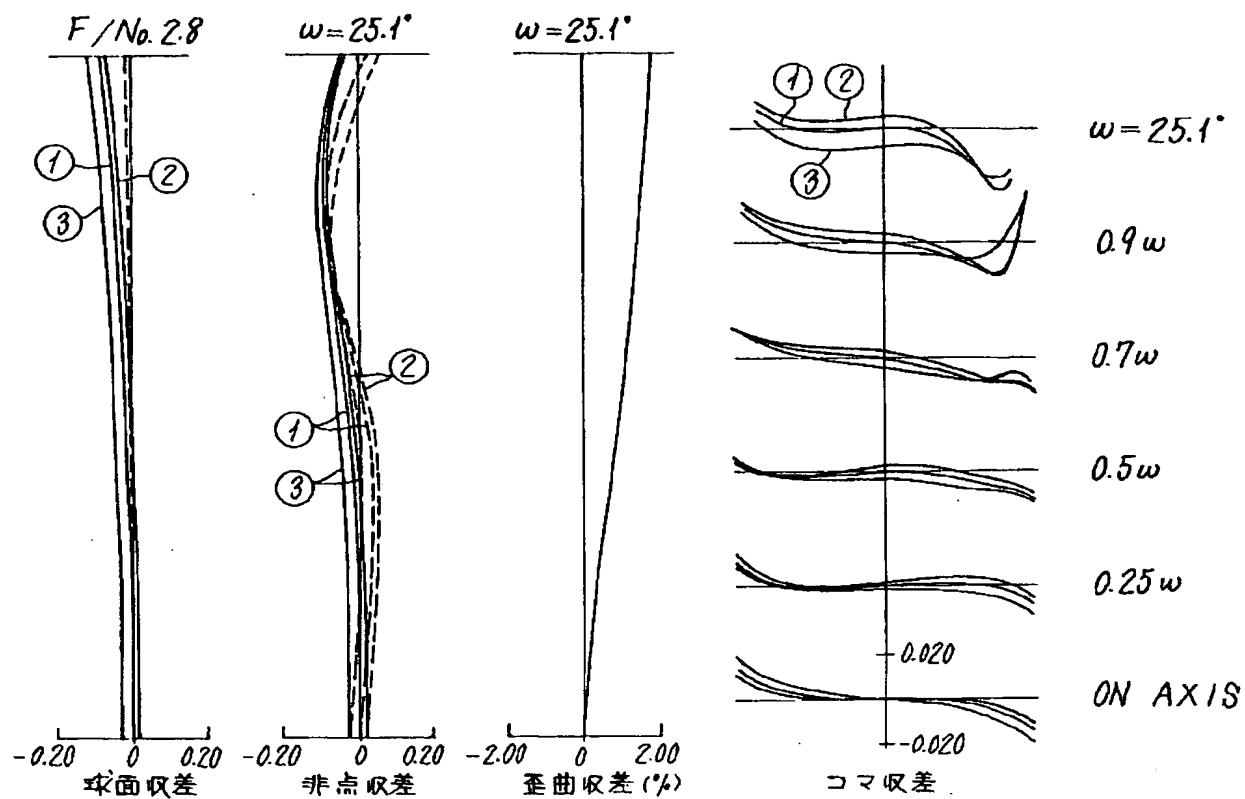
【図6】

(実施例5)



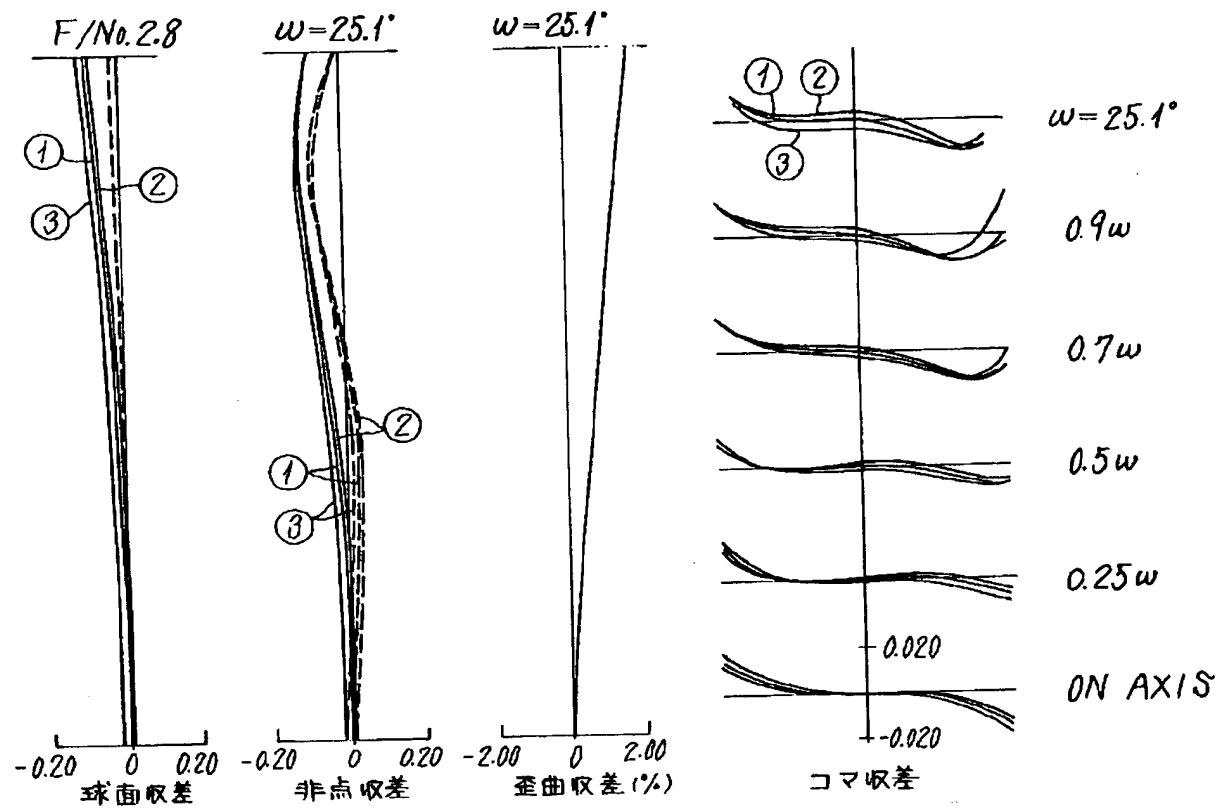
【図7】

(実施例6)



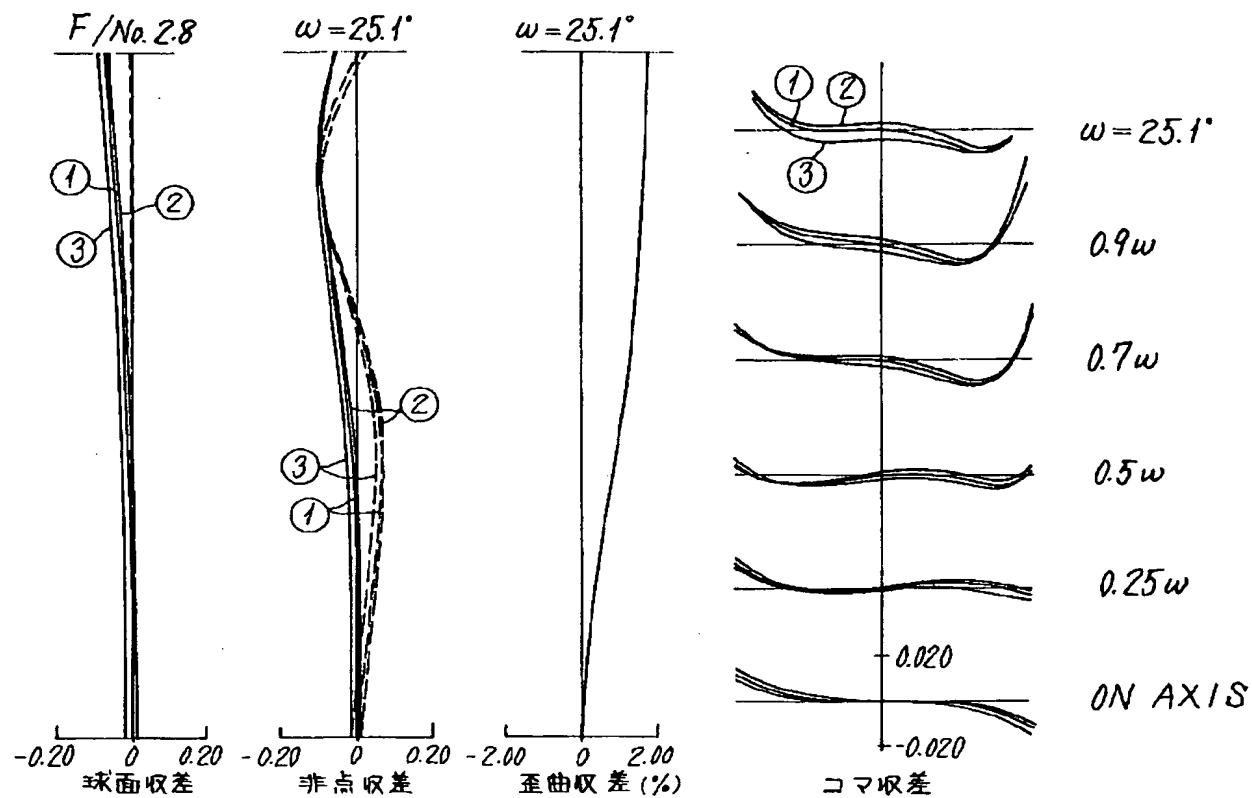
【図8】

(実施例7)



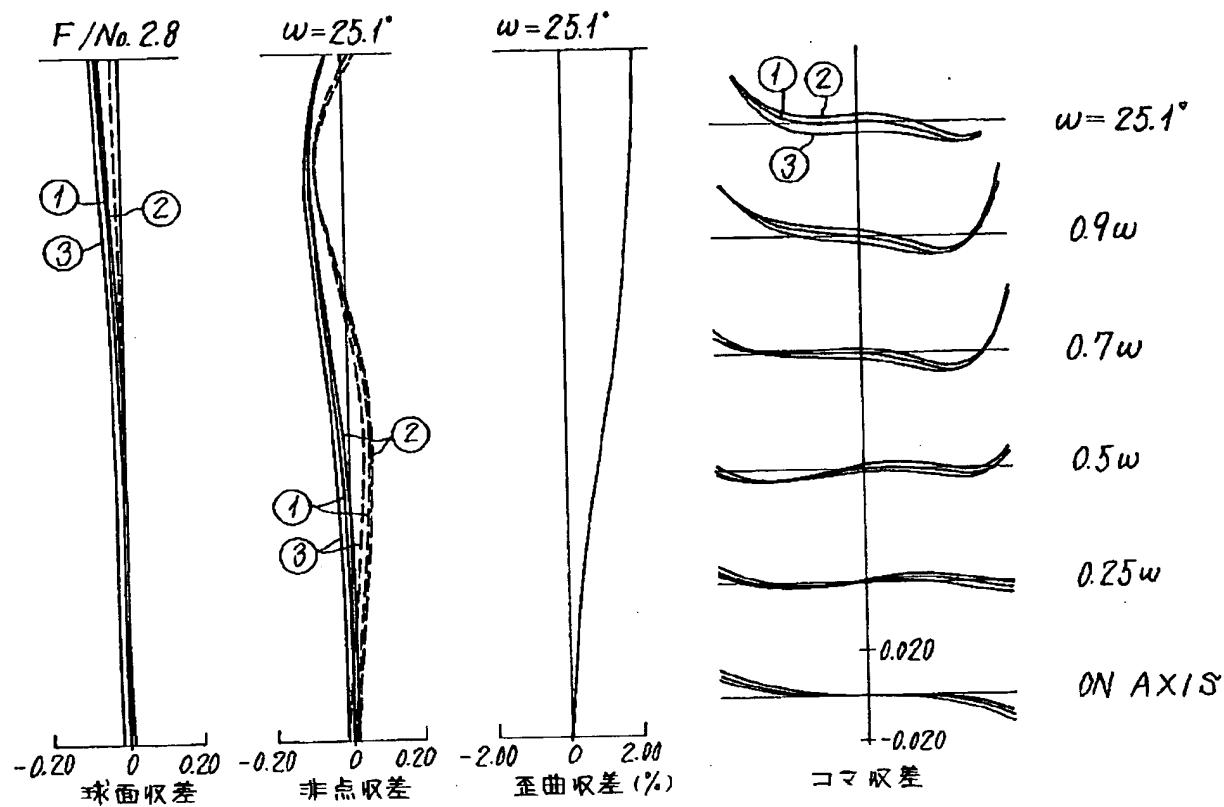
【図9】

(実施例8)



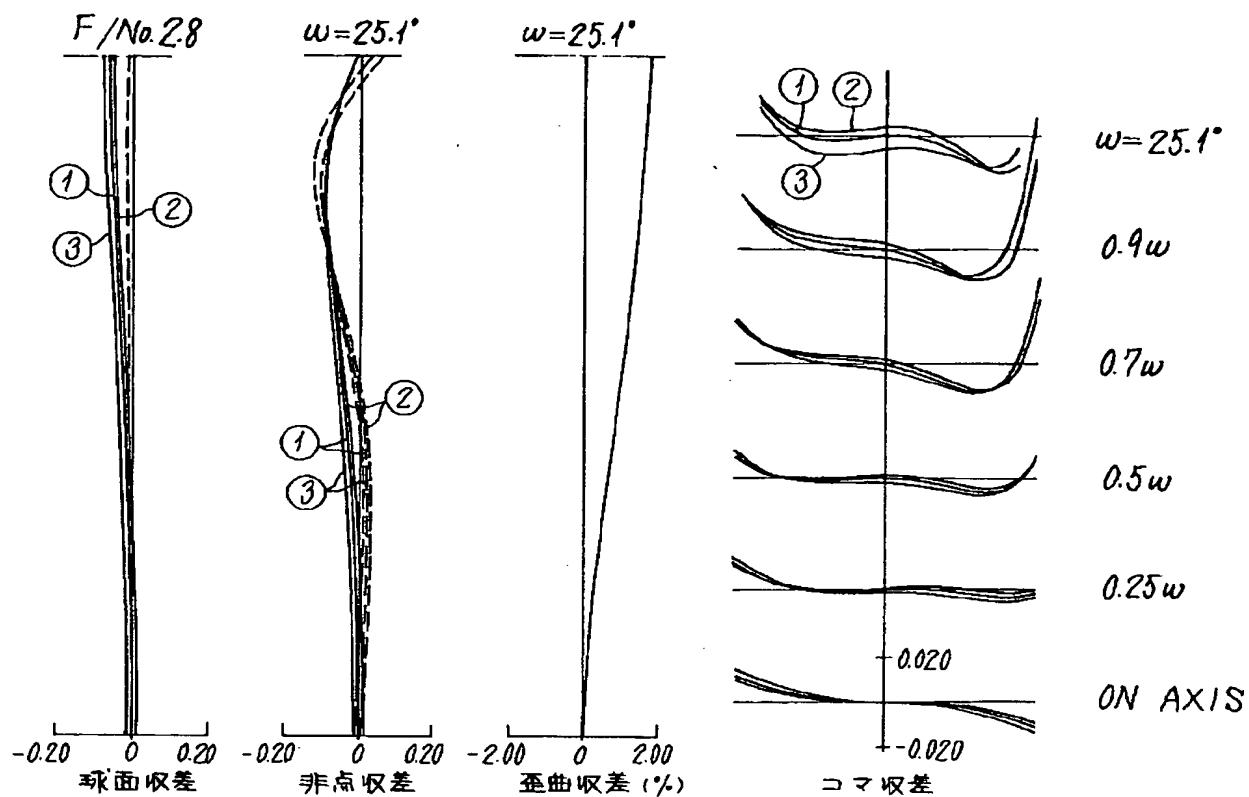
【図10】

(実施例9)



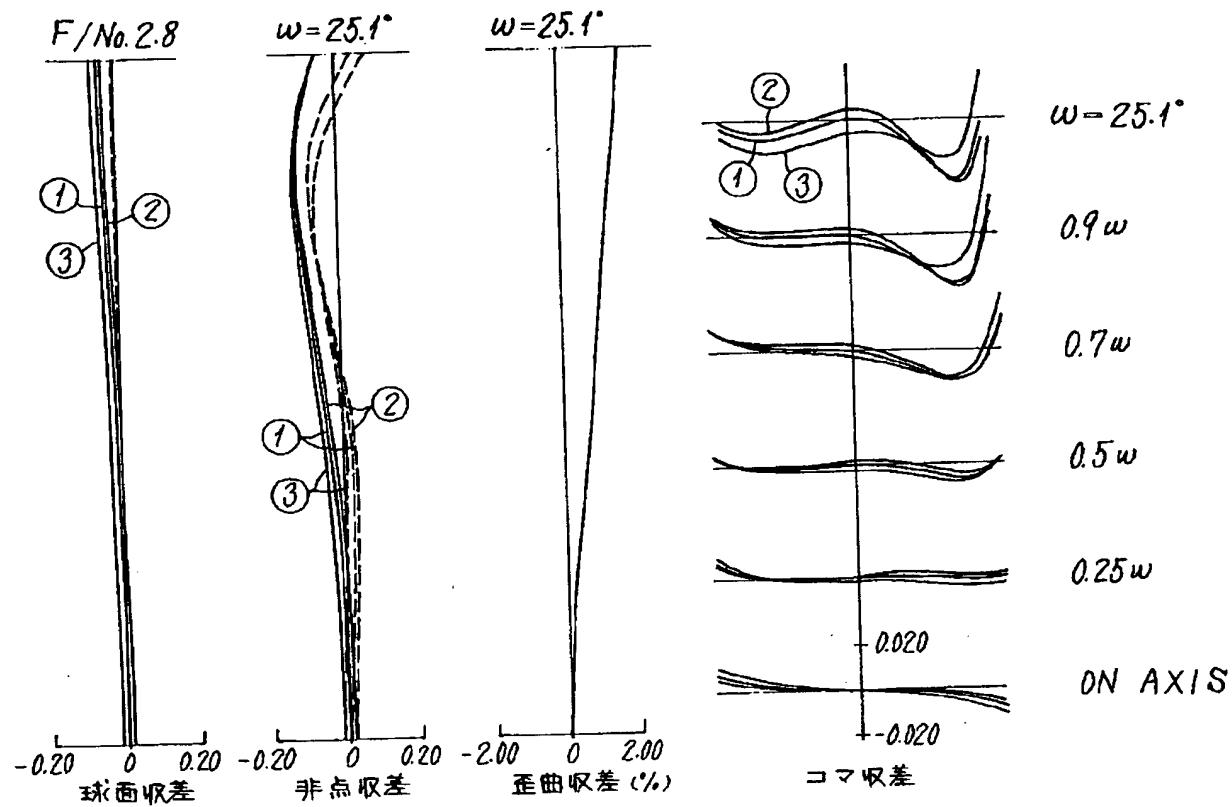
【図11】

(実施例10)



【図12】

(実施例11)



【図13】

(実施例12)

